ASSOCIATION CONNECTING
ELECTRONICS INDUSTRIES

IPC-1331

Voluntary Safety Standard for Electrically Heated Process Equipment

IPC-1331

March 2000

A standard developed by IPC

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www.ipc.org

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In May 1995 the IPC's Technical Activities Executive Committee adopted Principles of Standardization as a guiding principle of IPC's standardization efforts.

Standards Should:
- Show relationship to Design for Manufacturability (DFM) and Design for the Environment (DFE)
- Minimize time to market
- Contain simple (simplified) language
- Just include spec information
- Focus on end product performance
- Include a feedback system on use and problems for future improvement

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- Increase time-to-market
- Keep people out
- Increase cycle time
- Tell you how to make something
- Contain anything that cannot be defended with data

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Adopted October 6. 1998

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IPC-1331

Voluntary Safety Standard for Electrically Heated Process Equipment

Developed by the Health and Safety Subcommittee (4-32) of the Environmental Health and Safety Committee (4-30) of IPC

Users of this standard are encouraged to participate in the development of future revisions.

Contact:

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Acknowledgment

Any Standard involving a complex technology draws material from a vast number of sources. While the principal members of the Health and Safety Subcommittee (4-32) of the Environmental Health and Safety Committee (4-30) are shown below, it is not possible to include all of those who assisted in the evolution of this standard. To each of them, the members of the IPC extend their gratitude.

Environmental Health and Safety Committee	Health and Safety Subcommittee	Technical Liaisons of the IPC Board of Directors	
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John Lott	Lee Wilmot	Stan Plzak	Peter Bigelow
E.I. DuPont	Hadco	Pensar Corp.	Beaver Brook Circuits Inc.

Health and Safety Subcommittee

Collingham, Mark E., Griffin Ltd.

Girard, Joan, Electrotek Corp.

Heth, Michael, Allied Signal

Hoium, Brad, Advanced Flex Inc.

Lundquist, Robert, MNTAP (MN Technical Assistance Prog.)

Scott, Tim, Tyco Printed Circuit Group

Sella, Alon, Micro-Swiss

Tremblay, Russell J., M/A-COM Inc.

Voluntary Safety Standard for Electrically Heated Process Equipment

1 SCOPE

This voluntary standard establishes minimum requirements for the design, installation, operation and maintenance of electrically heated process equipment in order to minimize electrical hazards and prevent fires that may occur in combustible tanks, tank liners and drying equipment. It is intended to cover both liquid and gas (e.g., air) process heaters used in the manufacture of printed wiring boards (PWBs) and printed wiring assemblies (PWAs). Minimum requirements are indicated by the use of the term ‘‘shall.’’

Please note: This standard does not purport to address all safety issues associated with its use. Users should establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to standard's use.

2 REFERENCE DOCUMENTS

2.1 This Standard is intended to be compliant with the following regulations and codes:

29 CFR 1910 Subpart S-Electrical

ANSI C2-1997 National Electrical Safety Code

NFPA 70 National Electrical Code, Article 427 of National Electric Code

NFPA 79 National Fire Prevention Association

UL 499 Electric Heating Appliances

CSA C22.2 No. 88-1958 Industrial Heating Equipment

CEmark

3 GENERAL APPLICATION AND USE

3.1 Electric immersion heaters are generally used to heat aqueous or semi-aqueous solutions. They are not recommended for use with flammable solutions and **shall not** be used with class 1 or 2 flammable liquids.

3.2 Users **shall** verify with equipment and/or heater manufacturer and chemical supplier(s) that heater sheath material is compatible with the intended solution before installation and use. If user changes chemical composition, user **shall** ensure that heater sheath material is compatible with the new solution by checking with equipment and/or heater manufacturer.

3.3 Electric immersion heaters may ignite combustible tanks or liners. To prevent ignition, heating elements **shall** be securely mounted in a manner that prohibits direct contact with the tank or tank liner. Heating elements **shall** be located at least 25 mm [0.984 in] from the tank bottom and sidewalls or minimum distance recommended by manufacturer.

3.4 Electric heating elements, used in both liquid and gas process heating applications, **shall** be equipped with appropriate and adequate supports to prevent contact with combustible surfaces as a result of heating element deflection or sag due to use.

3.5 Electric immersion heaters **shall** be protected from physical damage. They **shall** be shielded or located to prevent physical damage from contact with other items entering tanks such as anodes, cathodes, racks, product, concentrated chemicals, and/or electrically charged components. Protection **shall** be accomplished by proper placement or appropriate guarding.

3.6 Heater elements **shall** be allowed to cool before they are removed from equipment for service or replacement.

3.7 Tanks **shall not** be drained until heater element has cooled.

3.8 Electric heating devices **shall** be built and tested to comply with a nationally recognized independent testing laboratory specification, Underwriters Laboratories (UL) and Factory Mutual (FM), for their intended application.

4 DESIGN AND INSTALLATION REQUIREMENTS

Electrically heated process equipment **shall** comply with the following design and installation requirements:

4.1 Control Circuit Design

4.1.1 A corrosion-resistant temperature-sensing element, such as a thermocouple, thermistor, or resistance thermal device (RTD), **shall** be used in conjunction with a temperature-indicating controller (see 4.1.2). The use of a thermostat with set point indication is also permitted. All sensing elements **shall** be compatible with the environment in which they are used (i.e., bath chemistry, fumes, or vapors) or be housed in a chemically compatible thermowell.

4.1.2 A temperature-indicating controller with both sensor break and short protection that provides an indication of process set point **shall** be used to provide temperature sensor open and short circuit protection. The controller **shall** allow the power control device (see 4.1.3) to be switched off when the tank temperature reaches the set point or when the system is not being used. A controller that displays the set point and the actual temperature at the same time is preferable because it allows an immediate evaluation of the system condition.

4.1.3 An appropriately sized power control device, such as a contactor relay, solid state relay (SSR), or silicon controlled rectifier (SCR), **shall** be used for controlling the availability or the amount of electrical power to the process heater.

4.1.4 All liquid process heater elements **shall** contain a thermal limit device, such as a fusible link, bimetallic thermostat, or other temperature regulating device, to detect an over-temperature condition in all installations where the possibility of combustion exists. The device **shall** disable power flow to the heating elements in the event of an over-temperature condition. This device may be non-resettable, manually reset, or automatically reset. If the device automatically resets, power flow to the heating elements **shall** be restricted from automatically resuming through use of manual latching circuit. Please note that the type of thermal limit device used will depend upon the technologies employed.

4.1.5 A temperature-sensing device **shall** be provided to protect electrically heated process equipment from over-temperature conditions. This device **shall** disable power flow to all heating elements in the event of an over-temperature condition. This device **shall** be unique to and redundant with the temperature-sensing element specified in 4.1.1. This device may be a pre-set temperature switch or a temperature-sensing element, such as a thermocouple, thermistor, or resistance thermal device (RTD) and its attendant hi-limit controller. The set point of this over-temperature device **shall** be set at a temperature value that is less than the maximum temperature limit of the equipment (i.e., when reached, no damage will occur to the chamber, lining, vessel or any other component contained within).

4.1.6 If an adjustable device or controller is used, the maximum adjustment position that is available **shall** be no greater than the equipment's maximum temperature limit (i.e., when reached, no damage will occur to the chamber, lining, vessel or any other component contained within).

4.1.7 If exothermic chemistries are present in the process vessel, the over-temperature device and associated cooling equipment **shall** be set at a temperature value to ensure that the exothermic action is controlled. The over-temperature set point for such chemistries **shall** be lower than the maximum temperature limit dictated by the materials of construction of the vessel or chamber used (i.e., when reached, no damage will occur to the chamber, lining, vessel or any other component contained within). Please note that the over-temperature limit **shall** be non-resettable to prevent resetting to an unsafe temperature, such as a temperature that is above an exothermic temperature.

4.1.8 An over-temperature controller for the over-temperature sensing device specified in 4.1.5 **shall** disable power flow to all heating elements in the event of an over-temperature condition. This over-temperature controller may be non-resettable, manually reset, or automatically reset. If the controller automatically resets, power flow to the heating elements **shall** be restricted from automatically resuming by the use of a manual latching circuit. The over-temperature controller **shall** activate a visible light and/or audible alarm to signal that an over-temperature condition exists.

4.1.9 For liquid tank heaters, a low-level switch **shall** be included in the electrical control circuit to disable the heater circuit power whenever the process liquid level drops to less than 25 mm [0.984 in] above the heater elements' hot zone. This switch **shall** also be equipped with a visible light and/or audible alarm to indicate that the switch has been activated. It is recommended that users choose low-voltage control circuits for monitoring low-level liquid sensors to prevent risk of shock.

4.1.10 For gas (e.g., air) process heaters, a low-flow switch **shall** be included in the electrical control circuit to disable the heater circuit power whenever the process gas (e.g., air) flow drops to a value just above the minimum flow required by the heating elements' manufacturer for gas (e.g., air) process heaters. This switch **shall** also be equipped with a visible light and/or audible alarm to indicate that the switch has been activated.

4.1.11 A separate safety interrupt contactor **shall** be included in the electrical control circuit and be wired in series with the thermally-used heater elements specified in 4.1.4 and activated by the temperature-sensing device specified in 4.1.5, the over-temperature controller specified in 4.1.6, the low liquid level switch specified in 4.1.9, or the low-flow switch specified in 4.1.10. This contactor **shall** be separate from the power control device sepcified in 4.1.3 to interrupt power flow to all heating elements in the case of an over-temperature condition.

4.1.12 An enable switch or process set point **shall** be included in the electrical control circuit to disable the heating control (not the safety interrupt controls) if process cooling is utilized in addition to process heating.

4.1.13 Where an exhaust fan is used to prevent the buildup of a flammable or toxic vapor, a safety interlock sensor such as a flow switch **shall** be included so as to interrupt power to the heaters in the event of fan malfunction. For a flammable vapor, the sensor should be set to actuate at not greater than 25 percent of the lower flammability limit.''

4.1.14 For liquid process heaters, Ground Fault Circuit Interrupters **shall** be employed with baths where solutions are known to be electrically charged.

4.1.15 Electric heater elements **shall** be equipped with a ground wire of sufficient size to carry any fault current. The construction of both heater and ground wire should be approved by a nationally recognized testing laboratory.

4.2 Control System Installation

4.2.1 For open-top tanks, the low-level switch sensing element **shall** be mounted in a way that allows the low-level setting to be tested without draining the contents of the tank. This will facilitate periodic testing of the liquid low level switch. For conveyorized equipment, the low-level switch **shall** be mounted to allow testing of the low-level switch sensing element without draining the sump level whenever possible.

4.2.2 The temperature-sensing element for the thermal over-temperature switch **shall** be mounted to facilitate testing without draining the tank or sump contents on liquid heaters. Thermostat temperature indicating sensors and hi-limit sensing devices **shall** be secured in a location below the minimum liquid level and above the bottom of the heating element.

4.2.3 Electrical wiring **shall** be designed and installed so as to minimize condensation and facilitate drainage of condensation away from electrical connections to prevent arcing, bridging and corrosion on the electrical connections.

4.2.4 All installation work **shall** be implemented in accordance with the latest edition of the National Electric Code.

4.3 Testing

4.3.1 Testing of all temperature sensing elements, limit controls and liquid level devices **shall** be performed by trained personnel on a periodic basis to ensure that all components are working properly and to assure the integrity of the safety interrupt circuit. Any failure **shall** be addressed by the user's corrective action policy.

4.3.2 All testing **shall** be documented. Records including corrective action **shall** be retained for a minimum of one year or per the record retention policy of the user.

4.3.3 Any replacement of a temperature-controlled circuit element **shall** be calibrated and proper operation **shall** be verified prior to placing into operation.

4.3.4 Calibration of the temperature controller specified in 4.1.2 should be performed per the manufacturer's recommendation, but no less than semiannually initially. It is recommended that facilities include this calibration requirement in the plant's calibration program.

4.3.5 Calibration of the over-temperature controller in 4.1.6 **shall** be performed as recommended by the manufacturer, but no less than annually.

4.4 Heating System Maintenance

4.4.1 All heater elements **shall** be periodically inspected and cleaned or as required per manufacturer recommendations to remove any deposits, which may inhibit heat transfer. Heaters used in additive operations may warrant more frequent inspection and maintenance.

4.4.2 All electrical power **shall** be turned off and locked out in accordance with site lock, tag and try procedures, and proper personal protection equipment worn prior to removing and inspecting heating elements.

4.4.3 The interchanging of parts, which were not included in the original heating system design, **shall** be limited unless advised by the equipment/heating manufacturer. Alternate parts can lead to failures resulting in either fire or physical injury.

IPC ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES

ANSI/IPC-T-50 Terms and Definitions for Interconnecting and Packaging Electronic Circuits Definition Submission/Approval Sheet

The purpose of this form is to keep current with terms routinely used in the industry and their definitions. Individuals or companies are invited to comment. Please complete this form and return to:

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2215 Sanders Road
Northbrook, IL 60062-6135
Fax: 847 509.9798

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❑ This is a **NEW** term and definition being submitted.
❑ This is an **ADDITION** to an existing term and definition(s).
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Term	Definition

If space not adequate, use reverse side or attach additional sheet(s).

Artwork: ❑ Not Applicable ❑ Required ❑ To be supplied
❑ Included: Electronic File Name: ______________________

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Date Received: ______________________
Comments Collated: ______________________
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Revision Inclusion: ______________________

Committee 2-30

Date of Initial Review: ______________________
Comment Resolution: ______________________
Committee Action: ❑ Accepted ❑ Rejected
❑ Accept Modify

IEC Classification

Classification Code • Serial Number

Terms and Definition Committee Final Approval Authorization:

Committee 2-30 has approved the above term for release in the next revision.

Name: ______________________ Committee: IPC 2-30 Date: ______________________

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The IPC staff will research your technical question and attempt to find an appropriate specification interpretation or technical response. Please send your technical query to the technical department via:

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For more information, contact Hugo Scaramuzza
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IPC conducts local educational workshops and national conferences to help you better understand emerging technologies. National conferences have covered Ball Grid Array and Flip Chip/Chip Scale Packaging. Some workshop topics include:

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- Troubleshooting the PWB Manufacturing Process
- Choosing the Right Base Material Laminate
- Acceptability of Printed Boards
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For more information on programs, contact John Riley
tel 847/790-5308 fax 847/509-9798
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Exhibitor information:
Contact: Jeff Naccarato
tel 630/434-7779

Registration information:
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Spring 2002
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Exhibitor information:
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For information on how to get involved, contact:
Jeanette Ferdman, Membership Manager
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ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES

Application for Site Membership

PLEASE CHECK APPROPRIATE CATEGORY

Thank you for your decision to join IPC. IPC Membership is **site specific,** which means that IPC member benefits are available to all individuals employed at the site designated on the other side of this application.

To help IPC serve your member site in the most efficient manner possible, please tell us what your facility does by choosing the most appropriate member category.

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Our facility manufactures and sells to other companies, printed wiring boards or other electronic interconnection products on the merchant market.

WHAT PRODUCTS DO YOU MAKE FOR SALE?

- ☐ One-sided and two-sided rigid printed boards
- ☐ Multilayer printed boards
- ☐ Flexible printed boards
- ☐ Flat cable
- ☐ Hybrid circuits
- ☐ Discrete wiring devices
- ☐ Other interconnections

Name of Chief Executive Officer/President____

■ **INDEPENDENT PRINTED BOARD ASSEMBLERS EMSI COMPANIES**

Our facility assembles printed wiring boards on a contract basis and/or offers other electronic interconnection products for sale.

- ☐ Turnkey
- ☐ SMT
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- ☐ Through-hole
- ☐ Mixed Technology
- ☐ Consignment
- ☐ BGA

Name of Chief Executive Officer/President____

■ **OEM – MANUFACTURERS OF ANY END PRODUCT USING PCB/PCAS OR CAPTIVE MANUFACTURERS OF PCBS/PCAS**

Our facility purchases, uses and/or manufactures printed wiring boards or other electronic interconnection products for our own use in a final product. Also known as original equipment manufacturers (OEM).

IS YOUR INTEREST IN:

- ☐ purchasing/manufacture of printed circuit boards
- ☐ purchasing/manufacturing printed circuit assemblies

What is your company's main product line?

____

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What products do you supply?

____

■ **GOVERNMENT AGENCIES/ ACADEMIC TECHNICAL LIAISONS**

We are representatives of a government agency, university, college, technical institute who are directly concerned with design, research, and utilization of electronic interconnection devices. (Must be a non-profit or not-for-profit organization.)

Please be sure to complete both pages of application.

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IPC
ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES

Company Name ______________________________

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Senior Management Contact ______________________________

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Please check one:

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ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES

Standard Improvement Form

IPC-1331

The purpose of this form is to provide the Technical Committee of IPC with input from the industry regarding usage of the subject standard.

Individuals or companies are invited to submit comments to IPC. All comments will be collected and dispersed to the appropriate committee(s).

If you can provide input, please complete this form and return to:

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1. I recommend changes to the following:

___ Requirement, paragraph number __________

___ Test Method number __________, paragraph number __________

The referenced paragraph number has proven to be:

___ Unclear ___ Too Rigid ___ In Error

___ Other ______________________________

2. Recommendations for correction:

____

____

____

____

3. Other suggestions for document improvement:

____

____

____

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